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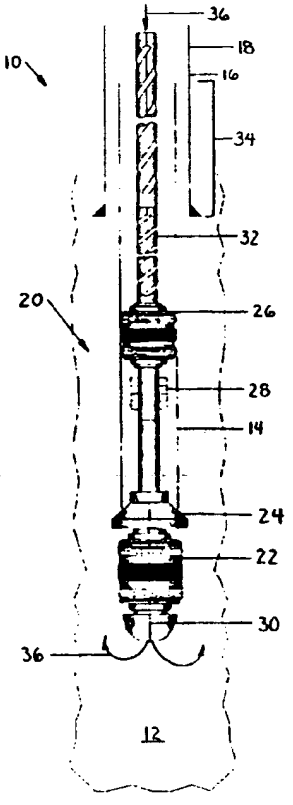
(54) Title: BOTTOM PLUG FOR FORMING A MONO DIAMETER WELLBORE CASING



(57) Abstract: A bottom plug and a method of using a bottom plug for forming a mono diameter wellbore casing is provided that includes an expandable packer initially attached below an expansion device. A packer setting mechanism is coupled between the expansion device and the expandable packer for expanding the expandable packer and sealingly setting it in an expanded portion of the wellbore casing. A release mechanism is coupled between the expansion device and the expandable bottom packer for releasing expandable bottom packer from the expansion device. Fluid is pumped into the wellbore casing between the cone and the set expandable bottom packer to facilitate forcing the expansion device into and through an unexpanded portion of the wellbore casing, thereby expanding the casing.

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BOTTOM PLUG FOR FORMING A MONO DIAMETER WELLBORE CASING

Cross Reference To Related Applications

[001] The present application claims the benefit of the filing date of (1) U.S. provisional patent application serial no. 60/412,488, attorney docket no 25791.114, filed on 9/20/2002, the disclosure of which is incorporated herein by reference.

[002] The present application is related to the following: (1) U.S. patent application serial no. 09/454,139, attorney docket no. 25791.03.02, filed on 12/3/1999, (2) U.S. patent application serial no. 09/510,913, attorney docket no. 25791.7.02, filed on 2/23/2000, (3) U.S. patent application serial no. 09/502,350, attorney docket no. 25791.8.02, filed on 2/10/2000, (4) U.S. patent no. 6,328,113, (5) U.S. patent application serial no. 09/523,460, attorney docket no. 25791.11.02, filed on 3/10/2000, (6) U.S. patent application serial no. 09/512,895, attorney docket no. 25791.12.02, filed on 2/24/2000, (7) U.S. patent application serial no. 09/511,941, attorney docket no. 25791.16.02, filed on 2/24/2000, (8) U.S. patent application serial no. 09/588,946, attorney docket no. 25791.17.02, filed on 6/7/2000, (9) U.S. patent application serial no. 09/559,122, attorney docket no. 25791.23.02, filed on 4/26/2000, (10) PCT patent application serial no. PCT/US00/18635, attorney docket no. 25791.25.02, filed on 7/9/2000, (11) U.S. provisional patent application serial no. 60/162,671, attorney docket no. 25791.27, filed on 11/1/1999, (12) U.S. provisional patent application serial no. 60/154,047, attorney docket no. 25791.29, filed on 9/16/1999, (13) U.S. provisional patent application serial no. 60/159,082, attorney docket no. 25791.34, filed on 10/12/1999, (14) U.S. provisional patent application serial no. 60/159,039, attorney docket no. 25791.36, filed on 10/12/1999, (15) U.S. provisional patent application serial no. 60/159,033, attorney docket no. 25791.37, filed on 10/12/1999, (16) U.S. provisional patent application serial no. 60/212,359, attorney docket no. 25791.38, filed on 6/19/2000, (17) U.S. provisional patent application serial no. 60/165,228, attorney docket no. 25791.39, filed on 11/12/1999, (18) U.S. provisional patent application serial no. 60/221,443, attorney docket no. 25791.45, filed on 7/28/2000, (19) U.S. provisional patent application serial no. 60/221,645, attorney docket no. 25791.46, filed on 7/28/2000, (20) U.S. provisional patent application serial no. 60/233,638, attorney docket no. 25791.47, filed on 9/18/2000, (21) U.S. provisional patent application serial no. 60/237,334, attorney docket no. 25791.48, filed on 10/2/2000, (22) U.S. provisional

patent application serial no. 60/270,007, attorney docket no. 25791.50, filed on 2/20/2001, (23) U.S. provisional patent application serial no. 60/262,434, attorney docket no. 25791.51, filed on 1/17/2001, (24) U.S. provisional patent application serial no. 60/259,486, attorney docket no. 25791.52, filed on 1/3/2001, (25) U.S. provisional patent application serial no. 60/303,740, attorney docket no. 25791.61, filed on 7/6/2001, (26) U.S. provisional patent application serial no. 60/313,453, attorney docket no. 25791.59, filed on 8/20/2001, (27) U.S. provisional patent application serial no. 60/317,985, attorney docket no. 25791.67, filed on 9/6/2001, (28) U.S. provisional patent application serial no. 60/3318,386, attorney docket no. 25791.67.02, filed on 9/10/2001, (29) U.S. utility patent application serial no. 09/969,922, attorney docket no. 25791.69, filed on 10/3/2001, (30) U.S. utility patent application serial no. 10/016,467, attorney docket no. 25791.70, filed on 12/10/2001, (31) U.S. provisional patent application serial no. 60/343,674, attorney docket no. 25791.68, filed on 12/27/2001, (32) U.S. provisional patent application serial no. 60/346,309, attorney docket no 25791.92, filed on 1/7/2002, (33) U.S. provisional patent application serial no. 60/372,048, attorney docket no. 25791.93, filed on 4/12/2002, (34) U.S. provisional patent application serial no. 60/380,147, attorney docket no. 25791.104, filed on 5/6/2002, (35) U.S. provisional patent application serial no. 60/387,486, attorney docket no. 25791.107, filed on 6/10/2002, (36) U.S. provisional patent application serial no. 60/387,961, attorney docket no. 25791.108, filed on 6/12/2002, (37) U.S. provisional patent application serial no. 60/391,703, attorney docket no. 25791.90, filed on 6/26/2002, (38) U.S. provisional patent application serial no. 60/397,284, attorney docket no. 25791.106, filed on 7/19/2002, (39) U.S. provisional patent application serial no. 60/398,061, attorney docket no. 25791.110, filed on 7/24/2002, (40) U.S. provisional patent application serial no, 60/405,610, attorney docket no. 25791.119, filed on 8/23/2002, (41) U.S. provisional patent application serial no. 60/405,394, attorney docket no. 25791.120, filed on 8/23/2002, (42) U.S. provisional patent application serial no. 60/412,177, attorney docket no. 25791.117, filed on 9/20/2002, (43) U.S. provisional patent application serial no. 60/412,653, attorney docket no. 25791.118, filed on 9/20/2002, (44) U.S. provisional patent application serial no. 60/412,544, attorney docket no. 25791.121, filed on 9/20/2002, (45) U.S. provisional patent application serial no. 60/412,187, attorney docket no. 25791.128, filed on 9/20/2002, (46) U.S. provisional patent application serial no. 60/412,187, attorney docket no. 25791.127, filed on

9/20/2002, (47) U.S. provisional patent application serial no. 60/412,487, attorney docket no. 25791.112, filed on 9/20/2002, (48) U.S. provisional patent application serial no. 60/412,542, attorney docket no. 25791.102, filed on 9/20/2002, and (49) U.S. provisional patent application serial no. 60/412,371 attorney docket no. 25791.129, filed on 9/20/2002, the disclosures of which are incorporated herein by reference.

Background of the Invention

[003] This invention relates generally to oil and gas exploration, and in particular to forming and repairing wellbore casings to facilitate oil and gas exploration.

[004] Conventionally, when a wellbore is created, a number of casings are installed in the borehole to prevent collapse of the borehole wall and to prevent undesired outflow of drilling fluid into the formation or inflow of fluid from the formation into the borehole. The borehole is drilled in intervals whereby a casing which is to be installed in a lower borehole interval is lowered through a previously installed casing of an upper borehole interval. As a consequence of this procedure the casing of the lower interval is of smaller diameter than the casing of the upper interval. Thus, the casings are in a nested arrangement with casing diameters decreasing in downward direction. Cement annuli are provided between the outer surfaces of the casings and the borehole wall to seal the casings from the borehole wall. As a consequence of this nested arrangement a relatively large borehole diameter is required at the upper part of the wellbore. Such a large borehole diameter involves increased costs due to heavy casing handling equipment, large drill bits and increased volumes of drilling fluid and drill cuttings. Moreover, increased drilling rig time is involved due to required cement pumping, cement hardening, required equipment changes due to large variations in hole diameters drilled in the course of the well, and the large volume of cuttings drilled and removed.

[005] The present invention is directed to overcoming one or more of the limitations of the existing procedures for forming and/or repairing wellbore casings.

Summary of the Invention

[006] According to one aspect of the present invention, a bottom plug for forming a mono diameter wellbore casing is provided.

Brief Description of the Drawings

[007] Fig. 1 is a schematic side view of a wellbore with an expandable tubular

member running into the wellbore supported at an end of a drill pipe by an expanding tool according to the invention.

[008] Fig. 2 is a schematic side view of a wellbore with a portion of the expandable tubular member expanded by the expanding tool of Fig. 1 to create a launcher section.

[009] Fig. 3 is a schematic side view of a wellbore with a bottom packer set in the launcher portion of the expandable tubular member and with the bottom packer released from the expander tool of Fig. 1.

[0010] Fig. 4 is a schematic side view of a wellbore with a bottom packer set in the launcher portion of the expandable tubular member and with the bottom packer released from the expander tool of Fig. 1 and with the expandable tubular member expanded with the expander tool activated by hydraulic pressure created between the bottom packer and an expansion cone of the expander tool of Fig. 1.

[0011] Fig. 5 is a schematic depiction of the engagement of a an anchor tool and the activation of a force multiplier in combination with the hydraulic pressure the cone to expand a bell at an overlapping portion between a previously expanded expandable member and the newly expanded expandable tubular member.

Detailed Description of the Illustrative Embodiments

[0012] Figs. 1-5 illustrate a bottom packer 22 used as part of an apparatus 10 and in connection with a method for forming a mono diameter wellbore casing 18 according several illustrative embodiments of the invention. In the exemplary embodiments illustrated the bottom packer 22 is used in connection with an expander tool 20 for expanding an expandable tubular member 14 in a wellbore 12. In several alternative embodiments, the invention is implemented using the methods and/or apparatus disclosed in one or more of the following: (1) U.S. patent application serial no. 09/454,139, attorney docket no. 25791.03.02, filed on 12/3/1999, (2) U.S. patent application serial no. 09/510,913, attorney docket no. 25791.7.02, filed on 2/23/2000, (3) U.S. patent application serial no. 09/502,350, attorney docket no. 25791.8.02, filed on 2/10/2000, (4) U.S. patent no. 6,328,113, (5) U.S. patent application serial no. 09/523,460, attorney docket no. 25791.11.02, filed on 3/10/2000, (6) U.S. patent application serial no. 09/512,895, attorney docket no. 25791.12.02, filed on 2/24/2000, (7) U.S. patent application serial no. 09/511,941, attorney docket no. 25791.16.02, filed on 2/24/2000, (8) U.S. patent application serial no. 09/588,946, attorney docket no. 25791.17.02, filed on 6/7/2000, (9) U.S. patent application serial no. 09/559,122,

attorney docket no. 25791.23.02, filed on 4/26/2000, (10) PCT patent application serial no. PCT/US00/18635, attorney docket no. 25791.25.02, filed on 7/9/2000, (11) U.S. provisional patent application serial no. 60/162,671, attorney docket no. 25791.27, filed on 11/1/1999, (12) U.S. provisional patent application serial no. 60/154,047, attorney docket no. 25791.29, filed on 9/16/1999, (13) U.S. provisional patent application serial no. 60/159,082, attorney docket no. 25791.34, filed on 10/12/1999, (14) U.S. provisional patent application serial no. 60/159,039, attorney docket no. 25791.36, filed on 10/12/1999, (15) U.S. provisional patent application serial no. 60/159,033, attorney docket no. 25791.37, filed on 10/12/1999, (16) U.S. provisional patent application serial no. 60/212,359, attorney docket no. 25791.38, filed on 6/19/2000, (17) U.S. provisional patent application serial no. 60/165,228, attorney docket no. 25791.39, filed on 11/12/1999, (18) U.S. provisional patent application serial no. 60/221,443, attorney docket no. 25791.45, filed on 7/28/2000, (19) U.S. provisional patent application serial no. 60/221,645, attorney docket no. 25791.46, filed on 7/28/2000, (20) U.S. provisional patent application serial no. 60/233,638, attorney docket no. 25791.47, filed on 9/18/2000, (21) U.S. provisional patent application serial no. 60/237,334, attorney docket no. 25791.48, filed on 10/2/2000, (22) U.S. provisional patent application serial no. 60/270,007, attorney docket no. 25791.50, filed on 2/20/2001, (23) U.S. provisional patent application serial no. 60/262,434, attorney docket no. 25791.51, filed on 1/17/2001, (24) U.S. provisional patent application serial no. 60/259,486, attorney docket no. 25791.52, filed on 1/3/2001, (25) U.S. provisional patent application serial no. 60/303,740, attorney docket no. 25791.61, filed on 7/6/2001, (26) U.S. provisional patent application serial no. 60/313,453, attorney docket no. 25791.59, filed on 8/20/2001, (27) U.S. provisional patent application serial no. 60/317,985, attorney docket no. 25791.67, filed on 9/6/2001, (28) U.S. provisional patent application serial no. 60/3318,386, attorney docket no. 25791.67.02, filed on 9/10/2001, (29) U.S. utility patent application serial no. 09/969,922, attorney docket no. 25791.69, filed on 10/3/2001, (30) U.S. utility patent application serial no. 10/016,467, attorney docket no. 25791.70, filed on 12/10/2001, (31) U.S. provisional patent application serial no. 60/343,674, attorney docket no. 25791.68, filed on 12/27/2001, (32) U.S. provisional patent application serial no. 60/346,309, attorney docket no 25791.92, filed on 1/7/2002, (33) U.S. provisional patent application serial no. 60/372,048, attorney docket no. 25791.93, filed on 4/12/2002, (34) U.S. provisional patent application serial no.

60/380,147, attorney docket no. 25791.104, filed on 5/6/2002, (35) U.S. provisional patent application serial no. 60/387,486, attorney docket no. 25791.107, filed on 6/10/2002, (36) U.S. provisional patent application serial no. 60/387,961, attorney docket no. 25791.108, filed on 6/12/2002, (37) U.S. provisional patent application serial no. 60/391,703, attorney docket no. 25791.90, filed on 6/26/2002, (38) U.S. provisional patent application serial no. 60/397,284, attorney docket no. 25791.106, filed on 7/19/2002, (39) U.S. provisional patent application serial no. 60/398,061, attorney docket no. 25791.110, filed on 7/24/2002, (40) U.S. provisional patent application serial no, 60/405,610, attorney docket no. 25791.119, filed on 8/23/2002, (41) U.S. provisional patent application serial no. 60/405,394, attorney docket no. 25791.120, filed on 8/23/2002, (42) U.S. provisional patent application serial no. 60/412,177, attorney docket no. 25791.117, filed on 9/20/2002, (43) U.S. provisional patent application serial no. 60/412,653, attorney docket no. 25791.118, filed on 9/20/2002, (44) U.S. provisional patent application serial no. 60/412,544, attorney docket no. 25791.121, filed on 9/20/2002, (45) U.S. provisional patent application serial no. 60/412,187, attorney docket no. 25791.128, filed on 9/20/2002, (46) U.S. provisional patent application serial no. 60/412,187, attorney docket no. 25791.127, filed on 9/20/2002, (47) U.S. provisional patent application serial no. 60/412,487, attorney docket no. 25791.112, filed on 9/20/2002, (48) U.S. provisional patent application serial no. 60/412,542, attorney docket no. 25791.102, filed on 9/20/2002, and (49) U.S. provisional patent application serial no. 60/412,371 attorney docket no. 25791.129, filed on 9/20/2002, the disclosures of which are incorporated herein by reference.

[0013] in Fig. 1 an expansion apparatus 10 is shown run-in a wellbore 12. The expansion apparatus carries a tubular member 14 to be expanded, in the wellbore 12, below a previously expanded tubular member 16 that forms part of an existing casing 18. The expansion apparatus 10 includes an expander tool 20 and a bottom packer 22 (sometimes referred to as a bottom plug). The expander tool 20, an anchor 26 (sometimes referred to as a gripping tool), a force multiplier 28 (sometimes referred to as a hydraulic actuator), the bottom packer 22, and a float shoe valve 30 all carried on a drill pipe 32. The float shoe valve 30 may be incorporated into the bottom packer 22.

[0014] In an exemplary embodiment the expansion cone 24 is a conventional expansion cone, or in the alternative is implemented using the methods and/or apparatus disclosed in one or more of the following: U.S. patent application serial no.

09/454,139, attorney docket no. 25791.03.02, filed on 12/3/1999; U.S. patent application serial no. 09/510,913, attorney docket no. 25791.7.02, filed on 2/23/2000; U.S. provisional patent application serial no. 60/380,147, attorney docket no. 25791.104, filed on 5/6/2002; and/or U.S. provisional patent application serial no. 60/387,961, attorney docket no. 25791.108, filed on 6/12/2002, the disclosures of which are incorporated herein by reference.

[0015] In an exemplary embodiment the anchor 26 is a conventional anchor or conventional gripping tool, or in the alternative is implemented using the methods and/or apparatus disclosed in one or more of the following: U.S. provisional patent application serial no. 60/380,147, attorney docket no. 25791.104, filed on 5/6/2002, and/or U.S. provisional patent application serial no. 60/387,961, attorney docket no. 25791.108, filed on 6/12/2002, the disclosures of which are incorporated herein by reference.

[0016] In an exemplary embodiment the force multiplier 28 or a conventional actuator such as a hydraulic actuator, or in the alternative is implemented using the methods and/or apparatus disclosed in one or more of the following: U.S. provisional patent application serial no. 60/380,147, attorney docket no. 25791.104, filed on 5/6/2002, and/or U.S. provisional patent application serial no. 60/387,961, attorney docket no. 25791.108, filed on 6/12/2002, the disclosures of which are incorporated herein by reference.

[0017] Before the expandable tubular member 14 is run-in, the wellbore 12 is drilled to a depth, below the previously expanded tubular member 16. The additional depth of the wellbore is estimated, based upon the length of the tubular member 14, to provide an overlap portion 34 between the previously expanded tubular member 16, or the existing casing 18, and the expandable tubular member 14 to be expanded.

[0018] In operation, the expandable tubular member 14 is inserted, or run-in, to the a position that results in the overlap at overlapping portion 34. The expandable tubular member 14 will typically be cemented into the wellbore12 by injecting fluid cement 36 through the drill pipe 32 and out through the float shoe valve 30 and into the wellbore below and around the bottom packer 22. The anchor 26 is activated, in a conventional manner or as disclosed in on or more of U.S. provisional patent application serial no. 60/380,147, attorney docket no. 25791.104, filed on 5/6/2002, and/or U.S. provisional patent application serial no. 60/387,961, attorney docket no. 25791.108, filed on

6/12/2002, the disclosures of which are incorporated herein by reference, thereby locking the tubular member 14 relative to the expander tool 20. In a conventional manner, or as disclosed in one or more of U.S. provisional patent application serial no. 60/380,147, attorney docket no. 25791.104, filed on 5/6/2002, and/or U.S. provisional patent application serial no. 60/387,961, attorney docket no. 25791.108, filed on 6/12/2002, the disclosures of which are incorporated herein by reference, the force multiplier 28 is initially stroked open to move the expansion cone 24 down and off of the end of the tubular member 14 providing an appropriate return flow path for the fluidic cement 36 so that cementing can be conveniently accomplished .

[0019] In Fig. 2, the force multiplier 28 is then stroked closed to move the expansion cone 24 firmly against the tubular member 14. The flow of fluidic material out of the float shoe 30 is stopped, for example, a valve in the float shoe may be closed by bumping the plug into the expansion cone assembly 24. Pressure builds in the force multiplier 28 to force the expansion cone 24 into the expandable tubular member 14 to pre-expand a lower section thereof and to thereby create a launcher section 38. The formed launcher section 38 is shown having an expanded inside diameter corresponding to the outside diameter of the expansion cone 24.

[0020] In Fig. 3, the displacement of the force multiplier 28 and expansion cone 24 releases the locked anchor 26. When the force multiplier 28 is fully closed the pressure will rise. Fluid is pumped to increase pressure within the apparatus 10 and to thereby set the bottom packer 22 in the launcher section 38. A conventional packer setting tool 40 or a conventional packer setting mechanism is used to expand and sealing set the bottom packer 22 in the launcher section 38. For example, as shown in a partial cross section through the bottom packer 22 in Fig. 3, such a setting tool 40 may be actuated conventionally by fluid pressure to progressively move together opposed conical wedge potions 42a and 42b of the bottom packer 22 and to progressively shear off shear pins 44a and 44b so that a flexible sealing ring 46 is compressed and expanded radially outward against the internal surface 48 of the launcher section 38. Also, opposed external gripping elements 50a and 50b are forced by the conical wedge portions 42a and 42b, radially outward to engage the internal surface 48 of the launcher section 38 so that the bottom packer 22 is set in a sealed position. With the bottom packer 22 set in the launcher 38, a conventional release mechanism 52 is activated to release the bottom packer 22 from the expansion cone 24. For example, the release mechanism

52 may be activated by a shear out release device or by a rotation release device 52. The bottom packer 22 is thus set and effectively acts as a shoe by sealing off the expandable tubular member 14 from the wellbore 12. Additional fluid 36 is pumped through the drill pipe 32 to below the expansion cone 24, causing a hydraulic pressure P to increase between the expansion cone 24 and the sealed bottom packer 22. The anchor 26 is released and the cone 24 is forced upward through the expandable tubular member 14 by the force F on the expansion cone 24 created by the hydraulic pressure P.

[0021] Fig. 4 shows that additional force may be required to move the expansion cone to expand the tubular member 14 at the overlap portion 30. Where the previously expanded tubular member 16 has that same inside diameter as the expanded inside diameter of the expandable tubular member 14, the cone 24 is effectively expanding both of the two overlapping tubular members 14 and 16 at the same time. In this situation either the pressure P needs to be increased or alternatively the anchor 26 can be engaged and the force multiplier 28 can be actuated to provide additional force for moving the expansion cone 24 through the overlap portion 34. At the overlapping portion 34 a bell 54 is formed in the existing previously expanded tubular member 16 to accommodate the outside diameter of the simultaneously expanded new expandable tubular member 14.

[0022] Fig. 5 shows one alternative operation of the expansion cone 24 run-in, after expansion of the expandable tubular member 14, to retrieve the bottom packer 22. A conventional oil tool retrieval mechanisms 56 may be used for this purpose.

[0023] In another alternative embodiment, the bottom packer 22 is a drillable packer so that after expansion of the tubular member 14, the remainder of the expander tool 20, with the expansion cone 22, the anchor 26 and the force multiplier 28 attached, is tripped out of the wellbore leaving the expanded expandable tubular member 14, as part of the formed mono diameter casing 18, and the bottom packer 22 in place. The drillable bottom packer 22 is drilled out of the casing 18 and the next portion of the wellbore 12 is drilled to a next desired depth. Another apparatus 10 is provided with another expandable tubular member carried on the expander tool and it is run-in and positioned in the wellbore overlapping the previously expanded expandable tubular member and is expanded as described above. The process may be repeated until the total desired depth of the wellbore with a mono diameter casing is formed.

[0024] Thus, a bottom plug for use in connection with an apparatus for forming a mono diameter wellbore casing, the apparatus of the type using an expandable tubular member carried into the wellbore on a tubular support and expanded with an expansion cone connected to the tubular support has been disclosed. The bottom plug includes an expandable packer attached below the expansion cone, a packer setting mechanism coupled between the expansion cone and the expandable packer for expanding the expandable packer and sealingly setting it in an expanded portion of the expandable tubular member and a release mechanism coupled between the expansion cone and the expandable packer for releasing the expandable bottom packer from the expansion cone such that fluid pumped into the expandable tubular member between the expansion cone and the sealed and set expandable bottom packer will force the expansion cone into and through the expandable tubular member to expand the expandable tubular member.

[0025] In another exemplary embodiment the bottom plug further includes a closable valve for selectively passing fluidic materials through the expandable packer into the wellbore.

[0026] In another exemplary embodiment of the bottom plug, the expandable packer is a drillable packer.

[0027] In another exemplary embodiment of the bottom plug, the expandable packer is a retrievable packer.

[0028] Also disclosed is an apparatus connectable to a drill pipe for forming a mono diameter wellbore casing that includes an expansion cone connected to the drill pipe, an expandable bottom packer coupled to and below the expansion cone, an expandable tubular member supported by the drill pipe above the expansion cone for insertion into the wellbore, an anchor device supported by the drill pipe within the expandable tubular member for releasably gripping the expandable tubular member, an actuator coupled between the anchor and the expansion cone for moving the cone partially into the expandable tubular member to form a first expanded portion of the expandable tubular member, a packer setting mechanism coupled between the expansion cone and the expandable bottom packer for expanding the expandable bottom packer and sealingly setting the expanded expandable bottom packer in the first expanded portion of the expandable tubular member, and a release mechanism coupled between the expansion cone and the expandable bottom packer for releasing

the expandable bottom packer from the expansion cone so that fluid pumped into the expandable tubular member between the expansion cone and the expandable bottom packer forces the expansion cone through the expandable tubular member to expand a second portion of the expandable tubular member.

[0029] In another exemplary embodiment the apparatus for forming a mono diameter wellbore casing further includes a closable valve for selectively passing fluidic materials through the expandable bottom packer into the wellbore.

[0030] In another exemplary embodiment the apparatus for forming a mono diameter wellbore casing the expandable bottom packer is a drillable packer.

[0031] In another exemplary embodiment the apparatus for forming a mono diameter wellbore casing the expandable bottom packer is a retrievable packer.

[0032] In another exemplary embodiment the bottom plug for use in connection with an apparatus for forming a mono diameter wellbore casing, the apparatus of the type using an expandable tubular member carried into the wellbore on a tubular support and expanded with an expansion device connected to the tubular support, the bottom plug includes an expandable packer attached below the expansion device, a packer setting mechanism coupled between the expansion device and the expandable packer for expanding the expandable packer and sealingly setting the expandable packer in an expanded portion of the expandable tubular member, and a release mechanism coupled between the expansion device and the expandable packer for releasing the expandable bottom packer from the expansion device so that fluid pumped into the expandable tubular member between the expansion device and the sealed and set expandable bottom packer will facilitate forcing the expansion device into and through the expandable tubular member to expand the expandable tubular member.

[0033] In another exemplary embodiment the bottom plug is used with an adjustable diameter expansion cone.

[0034] In another exemplary embodiment the bottom plug is used with a rotary expansion device.

[0035] In another exemplary embodiment the bottom plug is used with an adjustable diameter expansion rotary expansion device.

[0036] In another exemplary embodiment the bottom plug is used with a compliant expansion device.

[0037] In another exemplary embodiment the bottom plug is used with an adjustable

diameter expansion compliant expansion device.

[0038] In another exemplary embodiment the bottom plug is used with a hydroforming expansion device.

[0039] In another exemplary embodiment the bottom plug is used with an adjustable expansion diameter hydroforming device.

[0040] A method for forming a mono diameter wellbore casing is disclosed, including connecting an expansion cone to a tubular support, coupling an expandable bottom packer to and below the expansion cone, supporting an expandable tubular member with the tubular support at position above the expansion cone, inserting the expandable tubular member into the wellbore, expanding a first portion of the expandable tubular member with the expansion cone, sealingly setting the expanded expandable bottom packer in the first expanded portion of the expandable tubular member, releasing the expandable bottom packer from the expansion cone, and pumping fluid into the expandable tubular member between the expansion cone and the set and expanded expandable bottom packer will force the expansion cone through the expandable tubular member to expand a second portion of the expandable tubular member.

[0041] Another embodiment of the method for forming a mono diameter wellbore casing is disclosed wherein expanding the first portion of the expandable tubular member with the expansion cone further also includes releasably gripping the expandable tubular with an anchor device supported by the drill pipe within the expandable tubular member, coupling an actuator between the anchor and the expansion cone for moving the expansion cone with the actuator partially into the expandable tubular member to form a first expanded portion of the expandable tubular member.

[0042] In an alternative embodiment a method for forming a mono diameter wellbore casing is disclosed including connecting an expansion device to a tubular support, coupling an expandable bottom packer to and below the expansion device, supporting an expandable tubular member with the tubular support at position above the expansion device, inserting the expandable tubular member into the wellbore, expanding a first portion of the expandable tubular member with the expansion device, sealingly setting the expanded expandable bottom packer in the first expanded portion of the expandable tubular member, and releasing the expandable bottom packer from the expansion device, and pumping fluid into the expandable tubular member between the

expansion device and the set and expanded expandable bottom packer to facilitate forcing the expansion device through the expandable tubular member to expand a second portion of the expandable tubular member.

[0043] Another embodiment of the method for forming a mono diameter wellbore casing is disclosed wherein expanding the first portion of the expandable tubular member with the expansion device includes gripping the expandable tubular member with an anchor device supported by the drill pipe, coupling an actuator between the anchor and the expansion cone, and moving the expansion device with the actuator partially into the expandable tubular member to form the first expanded portion of the expandable tubular member.

[0044] Another embodiment of the method for forming a mono diameter wellbore casing is disclosed wherein expanding the first portion of the expandable tubular member with the expansion device further comprises expanding using an adjustable expansion device.

[0045] Another embodiment of the method for forming a mono diameter wellbore casing is disclosed wherein expanding the first portion of the expandable tubular member with the expansion device further includes expanding using a rotary expansion device.

[0046] Another embodiment of the method for forming a mono diameter wellbore casing is disclosed wherein expanding the first portion of the expandable tubular member with the expansion device further includes expanding using a compliant expansion device.

[0047] Another embodiment of the method for forming a mono diameter wellbore casing is disclosed wherein expanding the first portion of the expandable tubular member with the expansion device further comprises expanding using a hydroforming expansion device.

[0048] In several alternative embodiments, a conventional rotary expansion device, a conventional compliant expansion device, and/or a conventional hydroforming expansion device may used instead of, or in combination with, the expansion cone 24.

[0049] In several alternative embodiments, one or more of the conventional commercially available expansion devices available from Weatherford International, Baker Hughes, Halliburton Energy Services, Schlumberger, and/or Enventure Global Technology may be used instead of, or in combination with, the expansion cone

assembly 24.

[0050] It is understood that variations may be made in the foregoing without departing from the scope of the invention. For example, the teachings of the present illustrative embodiments may be used to provide a wellbore casing, a pipeline, or a structural support.

[0051] Although illustrative embodiments of the invention have been shown and described, a wide range of modification, changes and substitution is contemplated in the foregoing disclosure. In some instances, some features of the present invention may be employed without a corresponding use of the other features. Accordingly, it is appropriate that the appended claims be construed broadly and in a manner consistent with the scope of the invention.

Claims

What is claimed is:

1. A bottom plug for use in connection with an apparatus for forming a mono diameter wellbore casing, the apparatus of the type using an expandable tubular member carried into the wellbore on a tubular support and expanded with an expansion cone connected to the tubular support, the bottom plug comprising:

an expandable packer attached below the expansion cone;

a packer setting mechanism coupled between the expansion cone and the expandable packer for expanding the expandable packer and sealingly setting the expandable packer in an expanded portion of the expandable tubular member; and

a release mechanism coupled between the expansion cone and the expandable packer for releasing the expandable bottom packer from the expansion cone so that fluid pumped into the expandable tubular member between the expansion cone and the sealed and set expandable bottom packer will force the expansion cone into and through the expandable tubular member to expand the expandable tubular member.

2. The bottom plug of claim 1, further comprising a closable valve for selectively passing fluidic materials through the expandable packer into the wellbore.

3. The bottom plug of claim 1, wherein the expandable packer comprises a drillable packer.

4. The bottom plug of claim 1, wherein the expandable packer comprises a retrievable packer.

5. An apparatus connectable to a drill pipe for forming a mono diameter wellbore casing, comprising:

an expansion cone connected to the drill pipe;

an expandable bottom packer coupled to and below the expansion cone;

an expandable tubular member supported by the drill pipe above the expansion cone for insertion into the wellbore;

an anchor device supported by the drill pipe within the expandable tubular

member for releasably gripping the expandable tubular member;

an actuator coupled between the anchor and the expansion cone for moving the cone partially into the expandable tubular member to form a first expanded portion of the expandable tubular member;

a set mechanism coupled between the expansion cone and the expandable bottom packer for expanding the expandable bottom packer and sealingly setting the expanded expandable bottom packer in the first expanded portion of the expandable tubular member; and

a release mechanism coupled between the expansion cone and the expandable bottom packer for releasing the expandable bottom packer from the expansion cone such that fluid pumped into the expandable tubular member between the expansion cone and the expandable bottom packer will force the expansion cone through the expandable tubular member and will thereby expand a second portion of the expandable tubular member.

6. The apparatus of claim 5, further comprising a closable valve for selectively passing fluidic materials through the expandable bottom packer into the wellbore.

7. The apparatus of claim 5, wherein the expandable bottom packer comprises a drillable packer.

8. The apparatus of claim 5, wherein the expandable bottom packer comprises a retrievable packer.

9. A bottom plug for use in connection with an apparatus for forming a mono diameter wellbore casing, the apparatus of the type using an expandable tubular member carried into the wellbore on a tubular support and expanded with an expansion device connected to the tubular support, the bottom plug comprising:

an expandable packer attached below the expansion device;

a packer setting mechanism coupled between the expansion device and the expandable packer for expanding the expandable packer and sealingly setting the expandable packer in an expanded portion of the expandable tubular member; and

a release mechanism coupled between the expansion device and the

expandable packer for releasing the expandable bottom packer from the expansion device so that fluid pumped into the expandable tubular member between the expansion device and the sealed and set expandable bottom packer will facilitate forcing the expansion device into and through the expandable tubular member to expand the expandable tubular member.

10. The bottom plug of claim 9, wherein the expansion device comprises an expansion cone.

11. The bottom plug of claim 10, wherein the expansion cone comprises an adjustable diameter expansion cone.

12. The bottom plug of claim 9, wherein the expansion device comprises a rotary expansion device.

13. The bottom plug of claim 12, wherein the rotary expansion device comprises an adjustable diameter rotary expansion device.

14. The bottom plug of claim 9, wherein the expansion device comprises a compliant expansion device.

15. The bottom plug of claim 14, wherein the compliant expansion device comprises an adjustable diameter compliant expansion device.

16. The bottom plug of claim 9, wherein the expansion device comprises a hydroforming expansion device.

17. The bottom plug of claim 16, wherein the hydroforming expansion device comprises an adjustable expansion diameter hydroforming device.

18. A method for forming a mono diameter wellbore casing, comprising
connecting an expansion cone to a tubular support;
coupling an expandable bottom packer to and below the expansion cone;

supporting an expandable tubular member with the tubular support at position above the expansion cone;

inserting the expandable tubular member into the wellbore;

expanding a first portion of the expandable tubular member with the expansion cone;

sealingly setting the expanded expandable bottom packer in the first expanded portion of the expandable tubular member; and

releasing the expandable bottom packer from the expansion cone;

pumping fluid into the expandable tubular member between the expansion cone and the set and expanded expandable bottom packer to force the expansion cone through the expandable tubular member to expand a second portion of the expandable tubular member.

19. The method for forming a mono diameter wellbore casing of claim 18, wherein expanding the first portion of the expandable tubular member with the expansion cone further comprises

gripping the expandable tubular member with an anchor device supported by the drill pipe;

coupling an actuator between the anchor and the expansion cone; and

moving the expansion cone with the actuator partially into the expandable tubular member to form the first expanded portion of the expandable tubular member.

20. A method for forming a mono diameter wellbore casing, comprising

connecting an expansion device to a tubular support;

coupling an expandable bottom packer to and below the expansion device;

supporting an expandable tubular member with the tubular support at position above the expansion device;

inserting the expandable tubular member into the wellbore;

expanding a first portion of the expandable tubular member with the expansion device;

sealingly setting the expanded expandable bottom packer in the first expanded portion of the expandable tubular member; and

releasing the expandable bottom packer from the expansion device;

pumping fluid into the expandable tubular member between the expansion device and the set and expanded expandable bottom packer to facilitate forcing the expansion device through the expandable tubular member to expand a second portion of the expandable tubular member.

21. The method for forming a mono diameter wellbore casing of claim 20, wherein expanding the first portion of the expandable tubular member with the expansion device further comprises:

gripping the expandable tubular member with an anchor device supported by the drill pipe;

coupling an actuator between the anchor and the expansion cone; and

moving the expansion device with the actuator partially into the expandable tubular member to form the first expanded portion of the expandable tubular member.

22. The method for forming a mono diameter wellbore casing of claim 20, wherein expanding the first portion of the expandable tubular member with the expansion device further comprises expanding using an adjustable expansion device.

23. The method for forming a mono diameter wellbore casing of claim 20, wherein expanding the first portion of the expandable tubular member with the expansion device further comprises expanding using a rotary expansion device.

24. The method for forming a mono diameter wellbore casing of claim 20, wherein expanding the first portion of the expandable tubular member with the expansion device further comprises expanding using a compliant expansion device.

25. The method for forming a mono diameter wellbore casing of claim 20, wherein expanding the first portion of the expandable tubular member with the expansion device further comprises expanding using a hydroforming expansion device.

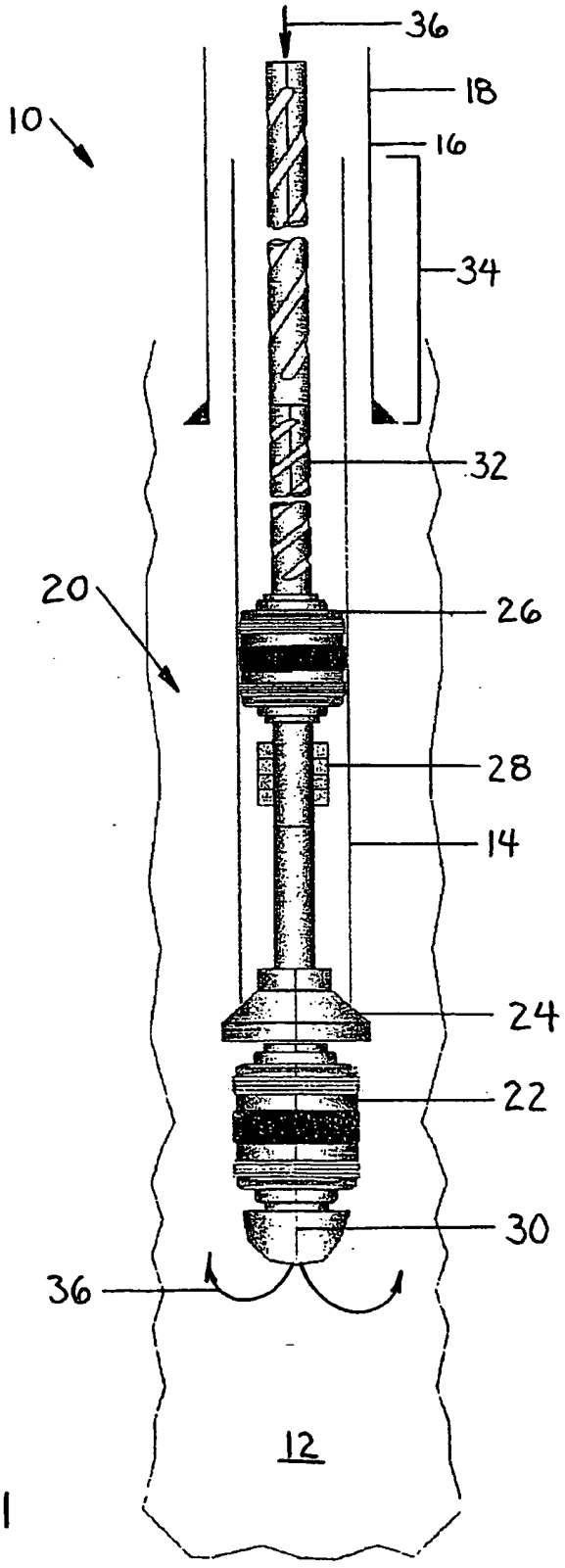

FIG. 1

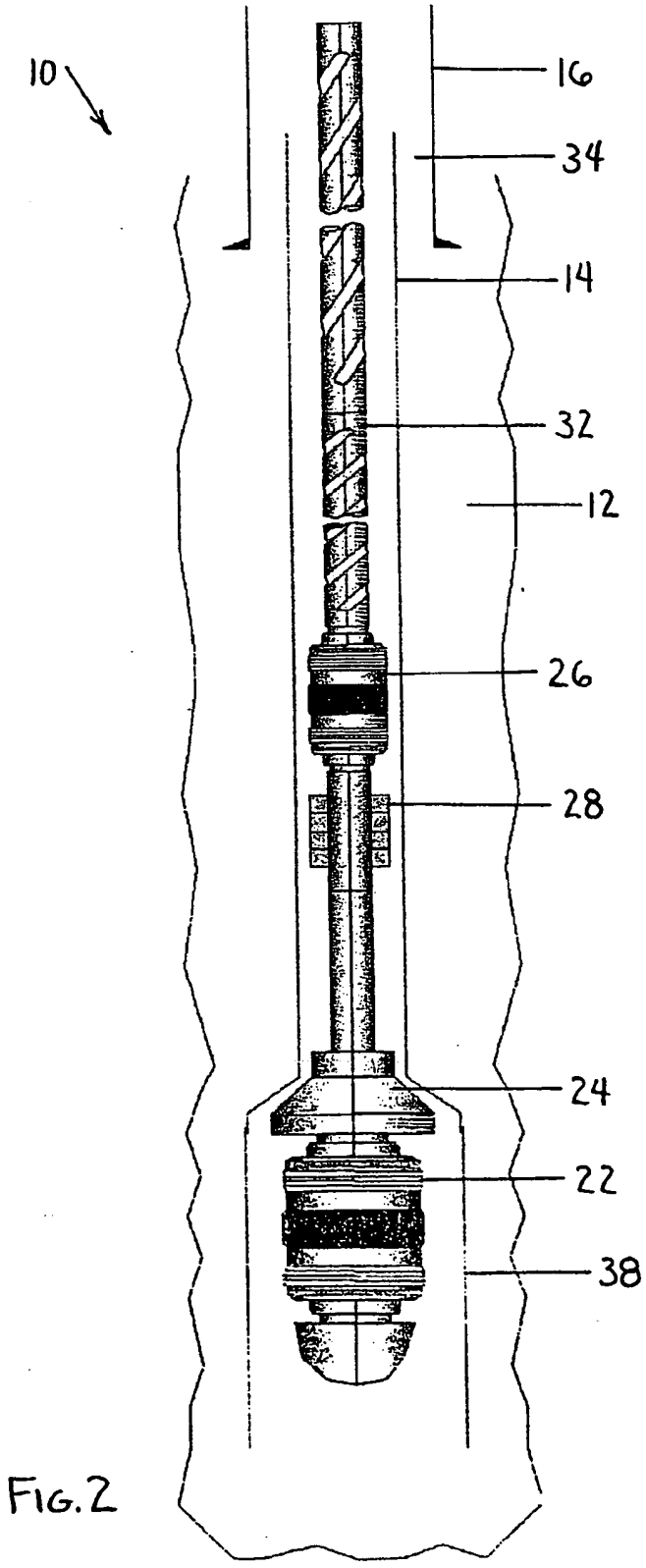

FIG. 2

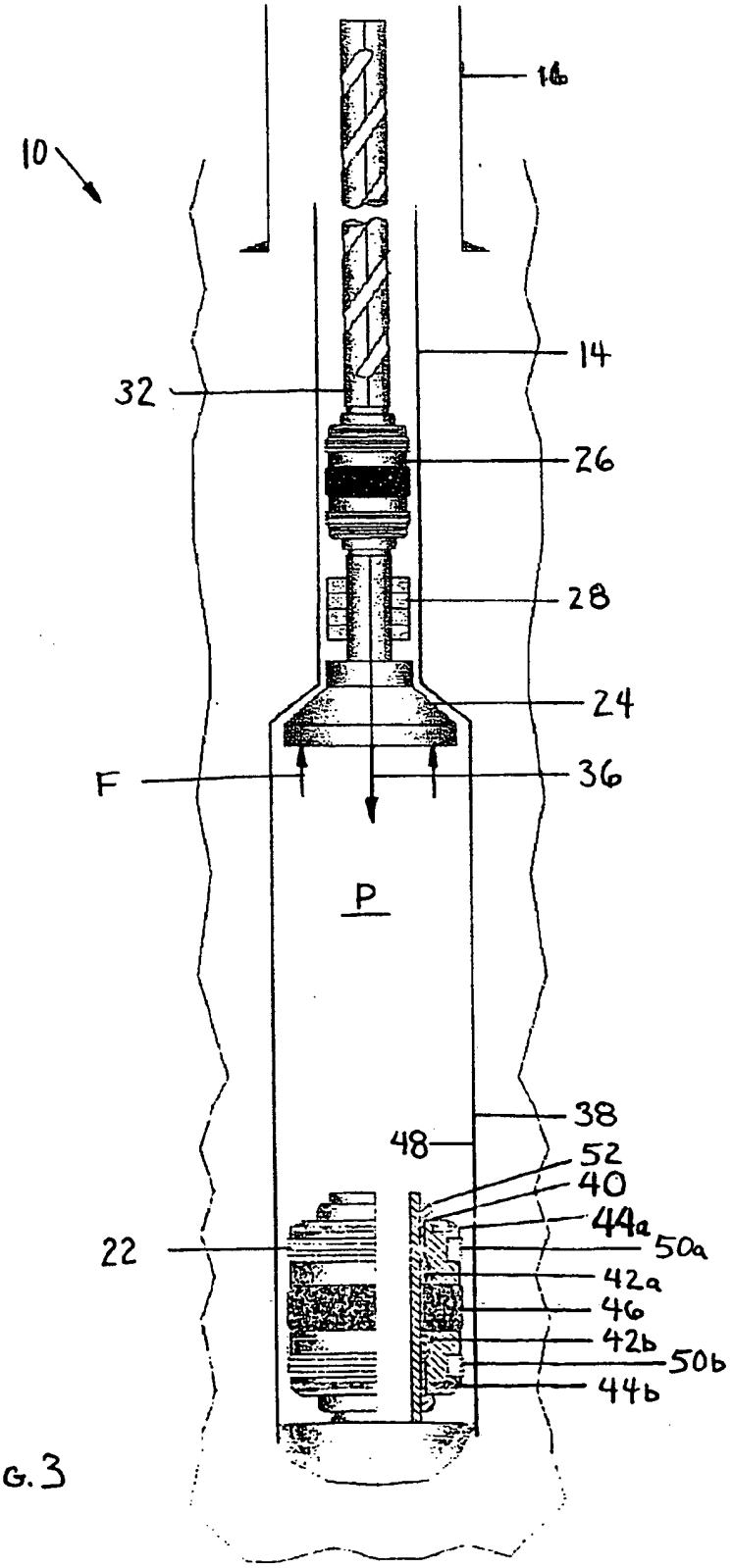

FIG. 3

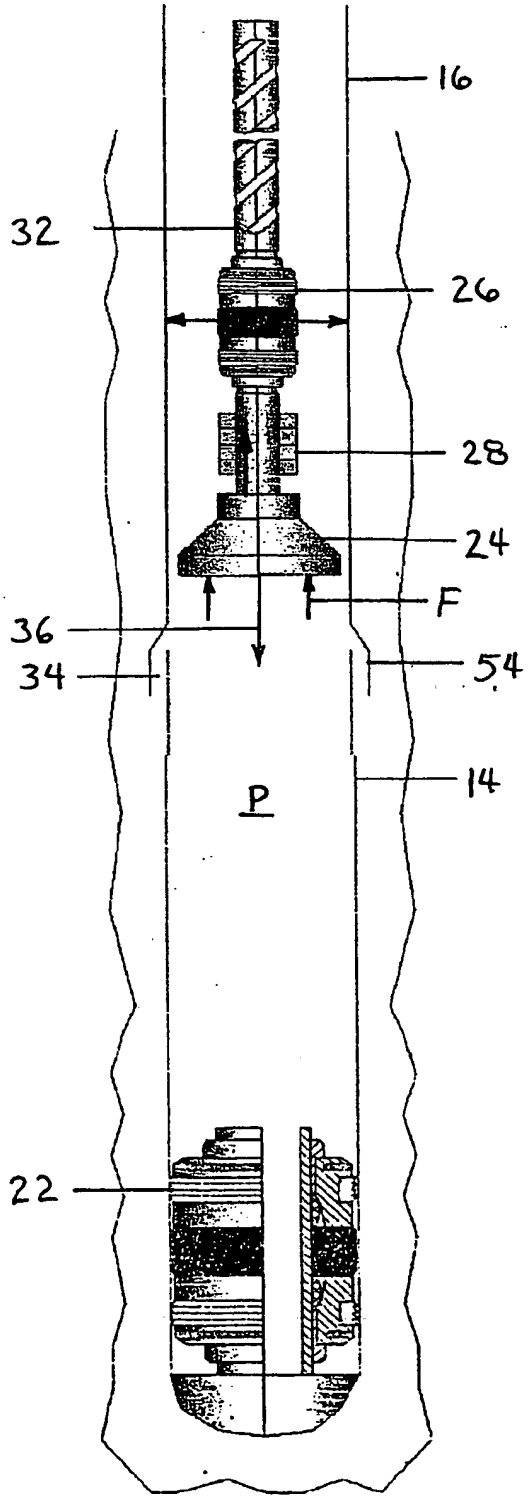

FIG. 4

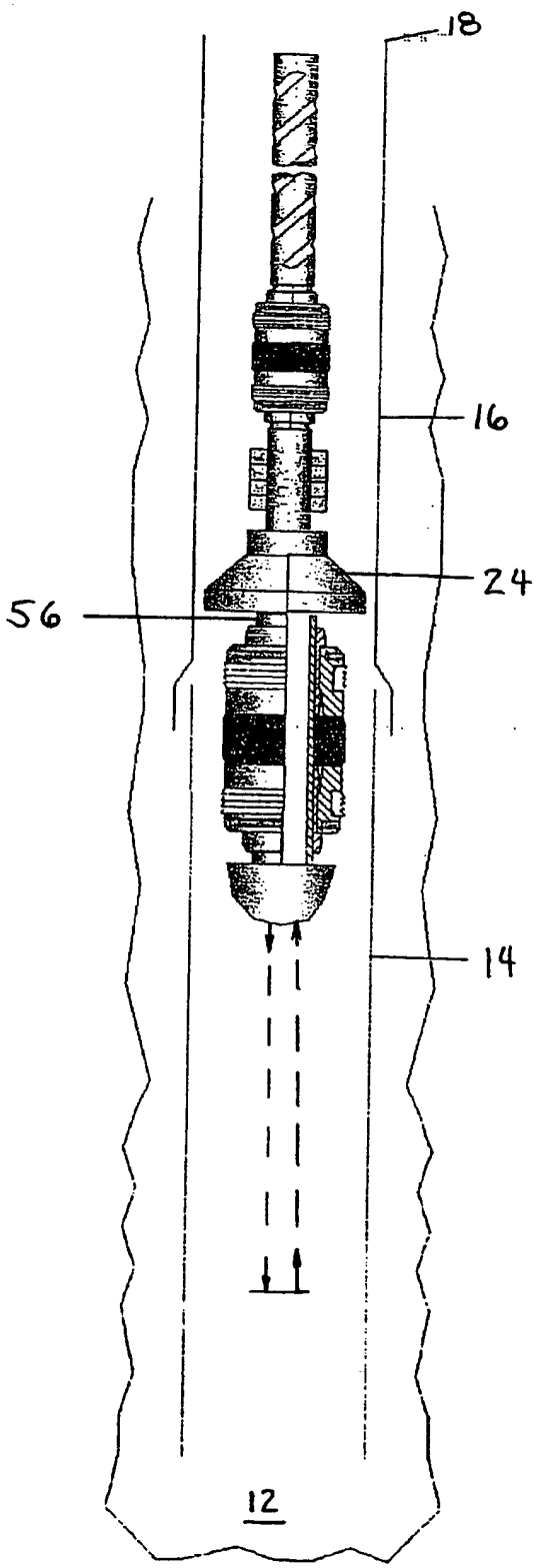

FIG. 5

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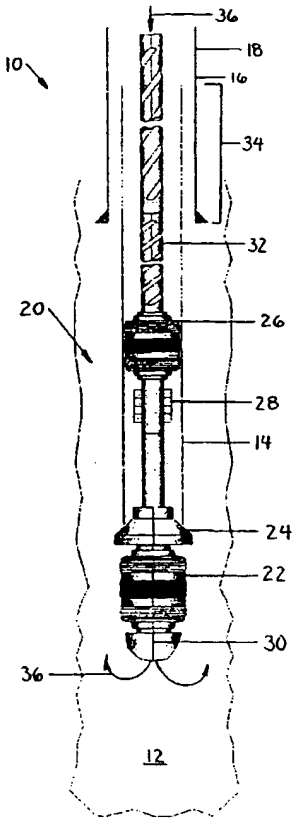
[Continued on next page]

(54) Title: BOTTOM PLUG FOR FORMING A MONO DIAMETER WELLBORE CASING



(57) Abstract: A bottom plug and a method of using a bottom plug for forming a mono diameter wellbore casing (18) is provided that includes an expandable packer (22) initially attached below an expansion device (24). A packer setting mechanism (40) is coupled between the expansion device (24) and the packer (22) for expanding a packer (22) and sealingly setting it in an expanded portion (38) of the wellbore casing (14). A release mechanism (52) is coupled between the expansion device (24) and the packer (22) for releasing packer (22) from the expansion device (24). Fluid (36) is pumped into the casing (14) between the cone (24) and the packer (22) to force the expansion device (24) into and through an unexpanded portion of casing (14), thereby expanding the casing (14).

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Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HU, IE, IT, LU, MC, NL, PT, RO, SE, SI, SK, TR), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

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AMENDED CLAIMS
[received by the International Bureau on 22 July 2004 (22.07.04);
Original claims 1-25 unchanged; new claims 26-49 added (7 pages).]

pumping fluid into the expandable tubular member between the expansion device and the set and expanded expandable bottom packer to facilitate forcing the expansion device through the expandable tubular member to expand a second portion of the expandable tubular member.

21. The method for forming a mono diameter wellbore casing of claim 20, wherein expanding the first portion of the expandable tubular member with the expansion device further comprises:

gripping the expandable tubular member with an anchor device supported by the drill pipe;

coupling an actuator between the anchor and the expansion cone; and

moving the expansion device with the actuator partially into the expandable tubular member to form the first expanded portion of the expandable tubular member.

22. The method for forming a mono diameter wellbore casing of claim 20, wherein expanding the first portion of the expandable tubular member with the expansion device further comprises expanding using an adjustable expansion device.

23. The method for forming a mono diameter wellbore casing of claim 20, wherein expanding the first portion of the expandable tubular member with the expansion device further comprises expanding using a rotary expansion device.

24. The method for forming a mono diameter wellbore casing of claim 20, wherein expanding the first portion of the expandable tubular member with the expansion device further comprises expanding using a compliant expansion device.

25. The method for forming a mono diameter wellbore casing of claim 20, wherein expanding the first portion of the expandable tubular member with the expansion device further comprises expanding using a hydroforming expansion device.

26. A method for forming a mono diameter wellbore casing, comprising

connecting an expansion cone to a tubular support;

supporting an expandable tubular member with the tubular support at a

position above the expansion cone;

inserting the expandable tubular member into the wellbore;

expanding a first portion of the expandable tubular member with the expansion cone;

sealing off the first expanded portion of the expandable tubular member; and

pumping fluid into the expandable tubular member between the expansion cone and the sealed off first expanded portion of the expandable tubular member to force the expansion cone through the expandable tubular member to expand a second portion of the expandable tubular member.

27. The method of claim 26, wherein expanding the first portion of the expandable tubular member with the expansion cone further comprises

gripping the expandable tubular member with an anchor device supported by the drill pipe;

coupling an actuator between the anchor and the expansion cone; and

moving the expansion cone with the actuator partially into the expandable tubular member to form the first expanded portion of the expandable tubular member.

28. A method for forming a mono diameter wellbore casing, comprising:

connecting an expansion device to a tubular support;

supporting an expandable tubular member with the tubular support at position above the expansion device;

inserting the expandable tubular member into the wellbore;

expanding a first portion of the expandable tubular member with the expansion device;

sealingly off the first expanded portion of the expandable tubular member; and

pumping fluid into the expandable tubular member between the expansion device and the sealed off first expanded portion of the expandable tubular member to facilitate forcing the expansion device through the expandable tubular member to expand a second portion of the

expandable tubular member.

29. The method of claim 28, wherein expanding the first portion of the expandable tubular member with the expansion device further comprises:

gripping the expandable tubular member with an anchor device supported by the drill pipe;

coupling an actuator between the anchor and the expansion cone; and

moving the expansion device with the actuator partially into the expandable tubular member to form the first expanded portion of the expandable tubular member.

30. The method of claim 28, wherein expanding the first portion of the expandable tubular member with the expansion device further comprises expanding using an adjustable expansion device.

31. The method of claim 28, wherein expanding the first portion of the expandable tubular member with the expansion device further comprises expanding using a rotary expansion device.

32. The method of claim 28, wherein expanding the first portion of the expandable tubular member with the expansion device further comprises expanding using a compliant expansion device.

33. The method of claim 28, wherein expanding the first portion of the expandable tubular member with the expansion device further comprises expanding using a hydroforming expansion device.

34. A system for forming a mono diameter wellbore casing, comprising

means for connecting an expansion cone to a tubular support;

means for coupling an expandable bottom packer to and below the expansion cone;

means for supporting an expandable tubular member with the tubular support at position above the expansion cone;

means for inserting the expandable tubular member into the wellbore;

means for expanding a first portion of the expandable tubular member with the expansion cone;

means for sealingly setting the expanded expandable bottom packer in the first expanded portion of the expandable tubular member;

means for releasing the expandable bottom packer from the expansion cone; and

means for pumping fluid into the expandable tubular member between the expansion cone and the set and expanded expandable bottom packer to force the expansion cone through the expandable tubular member to expand a second portion of the expandable tubular member.

35. The system of claim 34, wherein means for expanding the first portion of the expandable tubular member with the expansion cone further comprises

means for gripping the expandable tubular member with an anchor device supported by the drill pipe;

means for coupling an actuator between the anchor and the expansion cone; and

means for moving the expansion cone with the actuator partially into the expandable tubular member to form the first expanded portion of the expandable tubular member.

36. A system for forming a mono diameter wellbore casing, comprising

means for connecting an expansion device to a tubular support;

means for coupling an expandable bottom packer to and below the expansion device;

means for supporting an expandable tubular member with the tubular support at position above the expansion device;

means for inserting the expandable tubular member into the wellbore;

means for expanding a first portion of the expandable tubular member with the expansion device;

means for sealingly setting the expanded expandable bottom packer in the first expanded portion of the expandable tubular member;

means for releasing the expandable bottom packer from the expansion device; and

means for pumping fluid into the expandable tubular member between the expansion device and the set and expanded expandable bottom packer to facilitate forcing the expansion device through the expandable tubular member to expand a second portion of the expandable tubular member.

37. The system of claim 36, wherein means for expanding the first portion of the expandable tubular member with the expansion device further comprises:

means for gripping the expandable tubular member with an anchor device supported by the drill pipe;

means for coupling an actuator between the anchor and the expansion cone; and

means for moving the expansion device with the actuator partially into the expandable tubular member to form the first expanded portion of the expandable tubular member.

38. The system of claim 36, wherein means for expanding the first portion of the expandable tubular member with the expansion device further comprises means for expanding using an adjustable expansion device.

39. The system of claim 36, wherein means for expanding the first portion of the expandable tubular member with the expansion device further comprises means for expanding using a rotary expansion device.

40. The system of claim 36, wherein means for expanding the first portion of the expandable tubular member with the expansion device further comprises means for expanding using a compliant expansion device.

41. The system of claim 36, wherein means for expanding the first portion of the expandable tubular member with the expansion device further comprises means for expanding using a hydroforming expansion device.

42. A system for forming a mono diameter wellbore casing, comprising

means for connecting an expansion cone to a tubular support;

means for supporting an expandable tubular member with the tubular support at a position above the expansion cone;

means for inserting the expandable tubular member into the wellbore;

means for expanding a first portion of the expandable tubular member with the expansion cone;

means for sealing off the first expanded portion of the expandable tubular member; and

means for pumping fluid into the expandable tubular member between the expansion cone and the sealed off first expanded portion of the expandable tubular member to force the expansion cone through the expandable tubular member to expand a second portion of the expandable tubular member.

43. The system of claim 42, wherein means for expanding the first portion of the expandable tubular member with the expansion cone further comprises

means for gripping the expandable tubular member with an anchor device supported by the drill pipe;

means for coupling an actuator between the anchor and the expansion cone; and

means for moving the expansion cone with the actuator partially into the expandable tubular member to form the first expanded portion of the expandable tubular member.

44. A system for forming a mono diameter wellbore casing, comprising:

means for connecting an expansion device to a tubular support;

means for supporting an expandable tubular member with the tubular support at position above the expansion device;

means for inserting the expandable tubular member into the wellbore;

means for expanding a first portion of the expandable tubular member with the expansion device;

means for sealing off the first expanded portion of the expandable tubular member; and

means for pumping fluid into the expandable tubular member between the expansion device and the sealed off first expanded portion of the expandable tubular member to facilitate forcing the expansion device through the expandable tubular member to expand a second portion of the expandable tubular member.

45. The system of claim 44, wherein means for expanding the first portion of the expandable tubular member with the expansion device further comprises:

means for gripping the expandable tubular member with an anchor device supported by the drill pipe;

means for coupling an actuator between the anchor and the expansion cone; and

means for moving the expansion device with the actuator partially into the expandable tubular member to form the first expanded portion of the expandable tubular member.

46. The system of claim 44, wherein means for expanding the first portion of the expandable tubular member with the expansion device further comprises means for expanding using an adjustable expansion device.

47. The system of claim 44, wherein means for expanding the first portion of the expandable tubular member with the expansion device further comprises means for expanding using a rotary expansion device.

48. The system of claim 44, wherein means for expanding the first portion of the expandable tubular member with the expansion device further comprises means for expanding using a compliant expansion device.

49. The system of claim 44, wherein means for expanding the first portion of the expandable tubular member with the expansion device further comprises means for expanding using a hydroforming expansion device.